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Development of e-TBL to Analyze Critical Thinking Skills and Problem Solving in Learning of Substance and Characteristics

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Abstract

Electronic Task Based Learning (e-TBL) is learning by giving assignments to students assisted by electronic media so that students are more active. In SMPIT Izzatul Islam (SMPIT Izzis) Getasan e-TBL is not yet available to analyze critical thinking skills and problem solving on learning substance and characteristics. This research aims to develop a valid and reliable e-TBL to analyze critical thinking skills and problem solving in learning substance and characteristics and to find out the responses of users after using e-TBL as a result of development. Type of this research is the research and development of the 4D model. The subjects of this research were students of grade 8 SMPIT Izzis. A limited test was conducted to determine the readability of e-TBL, the feasibility of e-TBL, and user responses to e-TBL conducted with a questionnaire sheet that tested its validity and reliability. The data analysis technique used in this study was quantitative descriptive. Based on research results, the development of e-TBL is feasible to use because it is valid and reliable. Responses from users also show that the development of e-TBL is feasible to be used to analyze critical thinking skills and problem solving on learning substance and characteristics.

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INTRODUCTION

In the 21st century, quality human resources are needed who are able to work together, think at a high level, be creative, be skilled, be able to communicate and learn throughout life (Freeman, 2016). We are expected to be able to critically study various kinds of information obtained, process the information, and make the right decision in accordance with the problem being faced based on the results of the analysis conducted (Hafni, 2016). We also need to be creative in order to be able to solve the challenges of the 21st century that require innovation (Alismail & McGuire, 2015). In accordance with the challenges of the 21st century where teachers and students must be able to present effective and efficient learning, one of them is giving assignments to students (Freeman, 2016). One of the assignments given is assignments that are able to be used to analyze students' critical thinking and problem solving abilities (Memduhoğlu & Keleş, 2016).

Students can learn to find literature about what is learned, formulate thoughts, collect data, and solve problems that make students able to develop critical thinking skills (Mubaid, 2014). Assignment-based learning enables students to be more active and think logically in the learning process because everyone has the responsibility to complete assignments (Nurdiyanto et al., 2015). Students are given the opportunity to construct their knowledge, work together to solve problems, understand the material being studied in depth, communicate their thoughts and respond to the arguments of other groups practicing the development of critical thinking skills (Zhou et al., 2013).

The main purpose of science education is to develop critical thinking skills in students (Saido et al., 2015). Science learning, especially in the chemistry sub-chapter, still has many problems and is not as expected. This is because some concepts in chemistry are considered abstract (Sirhan, 2007). Lack of interest in learning will also affect students' critical thinking skills (Nugraha et al., 2017). Moreover, at the junior high school level, new students are dealing with chemistry. One of the subjects in the field of Natural Sciences, especially chemistry, is the substance and characteristics (Supardi & Luhbandjono, 2016).

Based on the results of interviews and observations at SMP Izzis Getasan, Semarang district there are several findings. Students do not fully understand science learning, especially substances and their characteristics, the assignments given have not led to 21st century educational goals, students have not been able to analyze critical thinking skills and problem solving in learning substances and their characteristics, learning has not been fully meaningful for students, innovation is needed for learning substances and their characteristics. One innovation that can be done is to give assignments to students who are different from usual. At SMPIT Izzis there is no e-TBL to analyze critical think skills and problem solving in learning substance and characteristics. Technological advances also need to be utilized to advance the world of education (Rahayu et al., 2013).

If during this assignment to students given face to face or directly it will be different from the existence of e-TBL. e-TBL is an assignment to students through electronic media aimed at honing students' abilities in the 21st century. As time goes by, face-to-face meetings in class can be replaced by independent assignments that can be accessed by students whenever and wherever they are (Mubaid, 2014). e-TBL is expected to be able to answer the challenges of the 21st century.

One of the advantages of using e-TBL is that it is able to analyze students' critical thinking skills and problem solving in accordance with the challenges of 21st century education. e-TBL is made more contemporary by making electronic-based assignments so that they are easily accessed anywhere and anytime. Technological advancements make things that were previously an obstacle easy to do (Irwansyah et al., 2017). This can be applied in schools that do not have laboratories or have limited equipment and materials in the laboratory.

Research results (Costa, 2016; Emir, 2009; Espinosa et al., 2017; Fatmawati et al., 2014; Nurdiyanto et al., 2015; Wulandari et al., 2017; and Zhao, 2011) show that TBL is suitable to be applied in learning. TBL is also suitable for use in chemistry learning (Nurmala et al., 2016; Qing et al., 2010; and Zhou et al., 2013). The advantage is through the assignments, students can choose directly the resources available to complete the task. TBL-based

learning can bring up existing initiatives in students and explore student knowledge independently. So thus in this learning, students can develop critical thinking skills and problem solving. e-TBL can also describe abstractness in chemistry learning. e-TBL can be an alternative assignment to students. A feasibility test is needed so that the developed e-TBL can be used to analyze critical thinking skills and problem solving on learning substance and characteristics.

The instrument due diligence is needed so that the instruments resulting from the development can be justified. The instrument is said to be feasible if it is valid and reliable (Khotimah et al., 2017). The validity of the instrument is carried out by experts according to their expertise. The e-TBL instrument was validated by the presentation, material and media experts. The reliability of the e-TBL user response questionnaire was calculated using Cronbach Alpha. The e-TBL developed used to analyze critical thinking skills and problem solving must contain indicators of critical thinking (Ennis, 1993) and indicators of problem solving (Polya, 1985). It takes a short amount of time to look at critical thinking and problem solving skills in students (Amalia & Susilaningsih, 2014).

Based on the description above, this research aims to develop e-TBL that is feasible to use to analyze critical thinking skills and problem solving in learning substance and characteristics and determine user responses after using e-TBL as a result of development.

METHODS

The research design uses research and development design with procedural models. Procedural model is a descriptive model with steps that must be taken to produce a product. The model used in this research is quantitative descriptive which aims to develop e-TBL that has been tested for eligibility. The e-TBL development uses the 4D research and development design with the stages of defining, designing, developing and disseminating (Thiagarajan, 1974). This research has only been carried out until the development stage and is followed by small-scale trials or limited trials. The definition stage is carried out by means of theoretical studies, potentials and problems, needs analysis. The design phase is carried out by designing e-TBL instruments based on the results of the defining stage. The development phase is carried out by validating e-TBL instruments by experts and revised according to expert input so that an e-TBL instrument is obtained which is ready to be tested in limited trials. The limited test was conducted on 15 students of SMPIT Izzis, 1 science teacher, and 2 observers. Limited testing is also conducted to determine the readability, feasibility, and response of user responses after using e-TBL development results.

The object of this research is a learning tool that is e-TBL instrument to analyze critical thinking skills and problem solving in learning substance and characteristics. The research instrument used in the assessment was the e-TBL validation sheet and the e-TBL user response questionnaire sheet. The e-TBL validation sheet serves to determine the level of readability and the feasibility or validity of e-TBL that is being developed. Feasibility is known from the results of validation by experts and reliability calculations (Amalia & Susilaningsih, 2014). User response questionnaire reliability was calculated using the Cronbach Alpha formula. Reliability of user response questionnaires can be obtained after e-TBL users fill out a list of questions that have been declared valid.

Data analysis technique used in this research is descriptive statistical analysis by calculating the results of validation by each expert. Scoring criteria are carried out to assess each item in the developed instrument. The method of calculation is done by calculating the score achieved in the instrument assessment. The analysis is carried out in the form of a Likert scale, i.e. each statement followed by several responses indicating the level (Arikunto, 2010). Responses to each statement are stated in 4 categories: SS (very agree) = point 4, S (agree) = point 3, CS (enough) = point 2, and TS (disagree) = point 1.

The formula is as follows.

lowest score = ∑ item x lowest grade

highest score = ∑ item x highest grade

range of score = lowest-highest score

with criteria scale:

criterion scale = (highest score-lowest score) / (∑ class)

After calculating the scale of the criteria, the scoring criteria can be determined. The level of feasibility of the product of development is

identified by the score criteria with a very good conclusion, good, good enough, and not good. Very good means the instrument can be used without revision, good meaning the instrument can be used with a few revisions, it is good enough meaning the instrument can be used with many revisions, and it is not good meaning the instrument cannot be used and still needs a lot of revisions.

Reliability is the degree of consistency of the instrument. The higher the reliability coefficient of a test, the higher the level of accuracy and magnitude, although the test is repeatedly tested it will still give relatively the same results (Arikunto, 2010). The reliability of the user tagging questionnaire was calculated using Cronbach Alpha reliability (Sugiyono, 2012). Reliable statement if $r_{11} \geq 0.8$. The Cronbach Alpha formula is as follows.

$$r_{11} = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum S_i^2}{S_t^2}\right]$$

Information:

r_{11} : reliability sought
k : number of statement items
$\sum S_i^2$: number of item variants
S_t^2 : total variant

RESULTS AND DISCUSSION

The results of this research are e-TBL instruments to analyze critical thinking skills and problem solving in learning substance and characteristics is valid and reliable. Validation is carried out to determine the level of readability and feasibility of the developed e-TBL instrument. Validation is carried out to determine the level of eligibility of the e-TBL instrument. The e-TBL instrument design consists of the cover page, content page, and cover page. The developed e-TBL instrument was validated by each of 3 validators according to their expertise. Teachers at SMPIT Izzis (validators 1, 2, and 3) who are in the field of curriculum as presentation worthiness experts that include the feasibility of interview sheets, syllabus, lesson plans, observation sheets, and user response questionnaire sheets. Postgraduate Lecturer in Chemistry Education at Universitas Negeri Semarang (validator 1) and science teacher at SMPIT Izzis (validators 2 and 3) as experts on material eligibility. Lecturer in the development of instructional media at Universitas Negeri Semarang (validators 1 and 2) and ICT teachers at SMPIT Izzis (validator 3) as media feasibility experts. The validation of the e-TBL instrument includes the format of presentation, graphics, content, linguistics, and usefulness. The validation curve of the e-TBL instrument is presented in Figure 1.

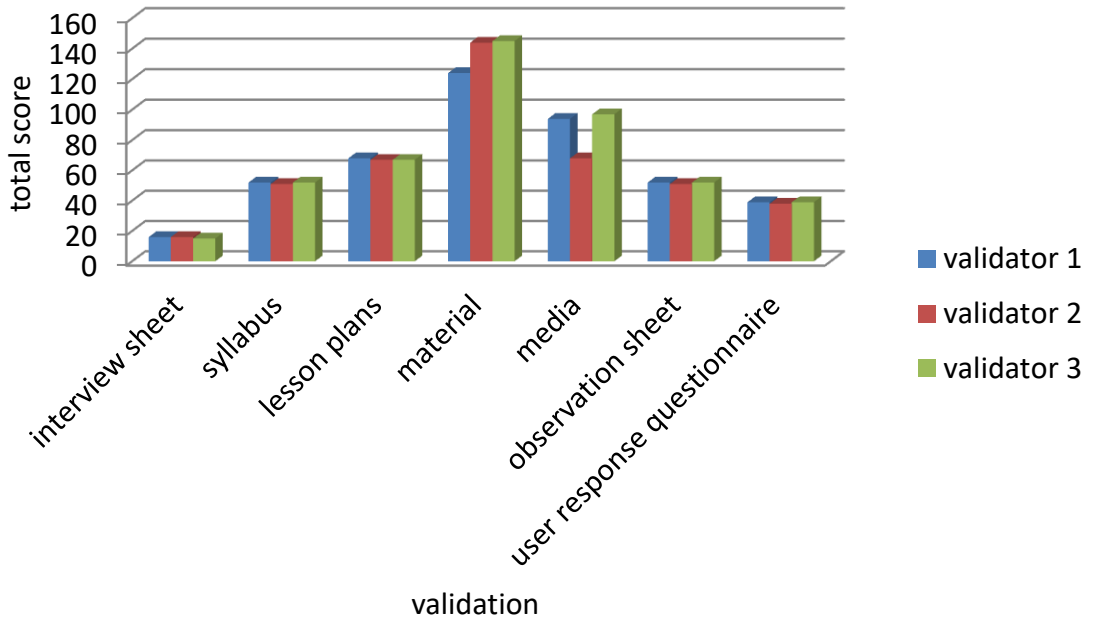


Figure 1. e-TBL Instrument Validation Curve

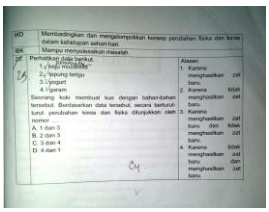
The interview sheet was validated by 3 experts namely SMPIT Izzis curriculum teachers as validators 1, 2, and 3. Validator 1 gave a score of 16 of the total score of 16. Validator 1 gave a score of 16 of the total score of 16. Validator 1 gave a score of 15 of the total score of 16 The results of the data validation of the interview sheets from three experts obtained a validation value of 3.92. Based on the scores obtained from each validator, the same conclusion is obtained that the interview sheet can be used without revision. But in reality, a slight revision was made in accordance with the input from the validator. The aim is to make the questionnaire better for use in collecting research data. Input provided by validator 3 is a question in accordance with the objectives of the study. Interview sheets can be used in research after being revised according to input from the validator.

The syllabus validation of substances and their characteristics was carried out by 3 validators from the SMPIT Izzis curriculum. Validators 1 and 2 are also science teachers at SMPIT Izzis, while validator 3 is also Indonesian language teachers. Validator 1 gives a total score of 52. Validator 2 gives a total score of 51. Validator 3 gives a total score of 52. The final validation value is 3.97. Based on the results of data processing, the syllabus of substances and their characteristics can be used without revision. Syllabus can be directly used in research.

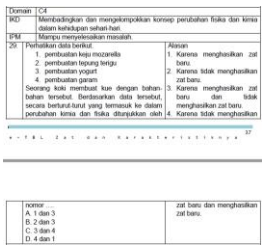
Validation of substance and characteristics lesson plans is done by 3 validators, namely curriculum teachers at SMPIT Izzis. Validator 1 gives a total score of 68. Validator 2 gives a total score of 67. Validator 3 provides a total score of 67. The validation value of the lesson plans is 3.96. Based on the results of data processing, the conclusion is the substance and characteristics of the lesson plans development results can be used without revision. There is a note for improvement from validator 3, namely there are two descriptions of the same learning objectives. After a slight revision of the input from the validator, the lesson plans is ready to use.

The e-TBL validation sheet by material experts was validated by 3 validators. Validator 1 is a Chemistry Post Graduate lecturer from Universitas Negeri Semarang, while validators 2 and 3 are science teachers at SMPIT Izzis. Validator 1 gives a total score of 124. Validator 2 with a total score of 144. Validator 3 gives a total score of 145. Validation value of e-TBL products by material experts is 3.72. Based on the results of data processing, it is concluded that e-TBL validated by material experts can be used without revision, but there are some input from the validator so that e-TBL is slightly revised before being used in research. Some notes from material experts, among others, need to deepen the material that can analyze the ability of students to think critically and problem solving, practice questions need to be revised so that it can be used to analyze students' ability to think critically and problem solving, and adjust the material with indicators of critical thinking skills and problem solving. Material on e-TBL before and after revision is presented in Figure 2.

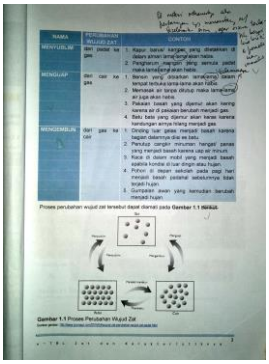
Before revision



After revision



Before revision



After revision

Figure 2. Material on e-TBL Before and After Revision

Validation of e-TBL products by media experts was carried out by 3 validators. Validators 1 and 2 are lecturers in the development of instructional media at Universitas Negeri Semarang. Validator 3 is an ICT teacher at SMPIT Izzis. Validator 1 gives a total score of 94. Validator 2 gives a total score of 68. Validator 3 gives a total score of 97. Validation value of 3.49. Based on the results of data processing it is concluded that e-TBL is very good and can be used for research without revision, but there are some input from the

validator. The validator provides input so that the front page cover is replaced which shows the contents of e-TBL more and uses images of personal documents as much as possible. The e-TBL display is based on input from media experts presented in Figure 3.

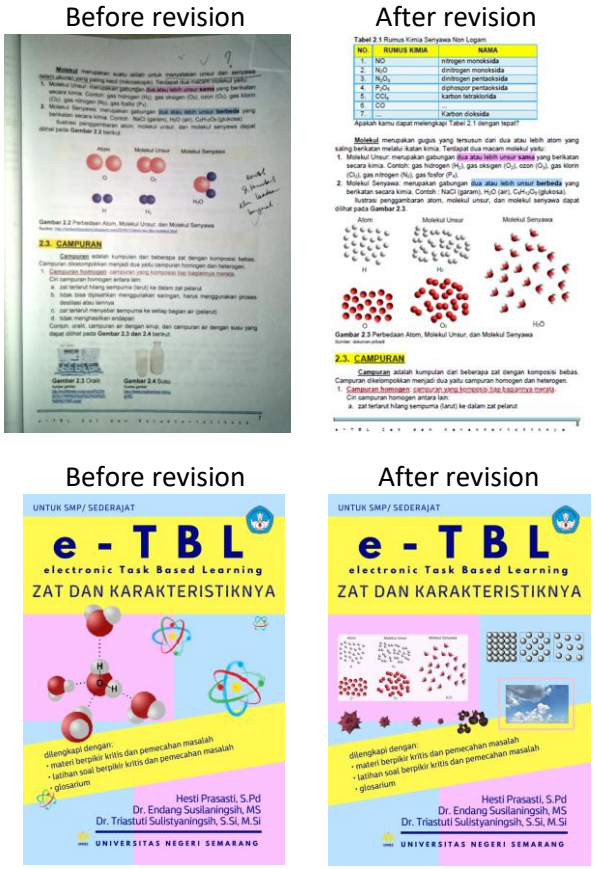


Figure 3. Display of e-TBL Based on Input from Media Specialists

The validation of the observation sheet was carried out by 3 validators, namely teachers from SMPIT Izzis. Validator 1 gives a total score of 68. Validator 2 gives a total score of 67. Validator 3 provides a total score of 67. The validation value of the observation sheet is 3.97. Based on the results of data processing, the observation sheet can be used without revision. Direct observation sheets can be used for research after being validated by experts.

The validation of the user tagging questionnaire sheet was carried out by 3 validators namely 3 teachers from SMPIT Izzis. Validator 1 is. Validator 1 gives a total score of 39. Validator 2 gives a total score of 38. Validator 3 gives a total score of 39. Validation questionnaire sheets of user responses is 3.87. Based on the results of data processing, it is obtained that a valid user response questionnaire sheet is used to retrieve research data.

The e-TBL instrument statement reliability is calculated using Cronbach Alpha formula. The results of the questionnaire sheets of user responses on limited trials obtained reliable results. The reliability of the user response questionnaire sheet in the limited trial is presented in Table 1.

Table 1. Reliability of User Response Questionnaire

Instrument	Reliability
Questionnaire responses of students on limited trials.	0.91
Questionnaire responses of teachers and observers on limited trials.	0.82

The reliability of the user response questionnaire sheet was divided into 2. First, the student questionnaire response sheet consisted of 12 statements. Second, the teacher and observer responses questionnaire sheet consisted of 10 statements. Each statement gives a statement of very agree, agree, enough, and disagree. The user response questionnaire sheet is filled in to find out the user's response after using the e-TBL developed. Curve results of student responses on limited trials are presented in Figure 3.

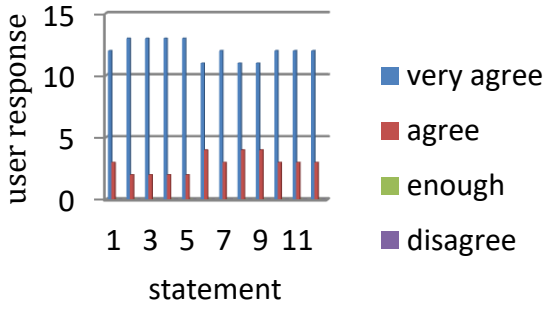


Figure 3. Curve Results of Student Responses on Limited Trials

Using e-TBL in science learning is fun 80% expressed very agree and 20% agree. Using e-TBL can visualize abstracts in learning substances and their characteristics 87% very agree and 13% agree. e-TBL caught the eye or did not get bored 87% very agree and 13% agree. Users reason that colored and pictorial e-TBLs attract eye attention. e-TBL makes it easy for me to remember material 87% expressed very agree and 13% agree. The reason given by users is that the use of different colors makes them

easy to remember, besides that language that is easy to understand also makes it easy to remember material. The language used in e-TBL is easy to understand 87% stated very agree and 13% agree. Feeling happy and easier to learn using e-TBL 73% expressed very agree and 27% agree. e-TBL is easy to use 80% very agree and 20% agree. Learning to use e-TBL requires a small fee 73% stated very agree and 27% agree. Users reason that e-TBL is cheap and easy to use because it is accessed by electronic media so it doesn't need to be printed much. The time spent on answering the practice questions is enough 73% stated very agree and 27% agree. Being able to think critically easily after using e-TBL 80% expressed very agree and 20% agree. Able to solve problems easily after using e-TBL 80% stated very agree and 20% agree. Users with the reason that very agree to give reasons for e-TBL are able to analyze the ability to think critically and solve problems because the questions are in accordance with indicators of critical thinking and problem solving. The overall appearance of e-TBL attracted 80% expressed very agree and 20% agree. Curve results of teacher responses and observers after using e-TBL are presented in Figure 4.

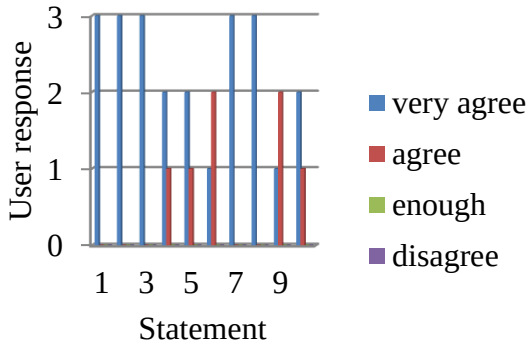


Figure 4. Curve Results of Teacher and Observer Responses on Limited Trials

100% users very agree that the e-TBL development is in accordance with the Basic Competency Indicators (IKD) and learning objectives, the material in e-TBL is in accordance with the learning objectives, there are general guidelines on how to use e-TBL, the presentation of pictures and tables in e-TBL Organized systematically, the e-TBL that was developed made it easier for teachers to analyze critical thinking skills and problem solving of students on the learning of substance and characteristics. This shows that e-TBL is very feasible to use. The general guidelines for using e-TBL are clearly conveyed, the choice of language used in e-TBL is easy to understand, and the appearance of e-TBL as a whole is interesting, the results of 67% expressed very agree and 33% agree. Not all users express very agree with the reason that the language used needs to be slightly adapted to the language of students to be easily understood. Presentation of reading texts in e-TBL is arranged systematically and e-TBL is easy to use by other teachers 33% expressed very agree and 67% agree. The user reasoned that not all teachers can easily use e-TBL because teachers who cannot operate computers will encounter problems when using e-TBL.

CONCLUSION

Based on the results of validity by experts, the e-TBL instrument which includes interview sheets, syllabus, lesson plans, material, media, observation sheets, and user response sheets is declared valid with a very good validity level. User response questionnaire reliability is more than 0.8. The reliability of student questionnaire responses to the trial was limited to 0.91 while the reliability of the questionnaire responses of teachers and observers was 0.82. Based on this, the development of e-TBL to analyze critical thinking skills and problem solving in learning substance and characteristics is appropriate to be used because it is valid and reliable. User responses after using e-TBL also showed positive results

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